Application Number 10/573,239
Amendment dated June 23, 2008
Response to Office action of March 24, 2008

Amendments to the Drawings:

The attached sheet of drawings includes changes to Fig 1B. This sheet, which includes Figs 1A-C and replaces the original sheet including Figs 1A and 1B. Figure 1 has been amended to read Figure 1A, and Figure 1C has been added.

Attachment: Replacement Sheet
Annotated Sheet Showing changes

Remarks/Arguments

Objections to the Drawings

The drawings are objected to because the 'emitter coated with a layer of band gap material' of Claim 1 is not shown. Applicant's comments are based on the assumption that assumes that Examiner meant Claim 2 since the limitation "emitter coated with a layer of band gap material" is not recited in claim 1.

Applicant has introduced Figure 1C to show a layer of band gap material **104** on emitter **102**. No new material is added by this amendment since the emitter coated with a layer of band gap material is explicitly disclosed in paragraph [0008].

Applicant has amended claim 2 to specify that the emitter may be a metal, and has added new claim 21 to specify that the emitter may be coated with a band gap material, as shown in Figure 1C.

Objections to the claims

Applicant has amended claims 4 and 15 in accordance with Examiner's requirement.

Claim Rejections – 35 USC 112

Claim 13 stands rejected under 35 USC 112. Claim 12 stands rejected since the phrase 'preventing back tunneling of electrons' can be understood to imply that back tunneling of electrons is completely stopped, whereas, according to the laws of quantum mechanics, this can never be the case. Applicant has accordingly amended the claim by reciting that back tunneling of electrons is suppressed, implying a reduction but not total cessation of backtunneling.

No new material is added by this amendment since suppression of backtunneling is explicitly disclosed in paragraph [0014] of the specification.

Claim 4 stands rejected under 35 USC 112 as containing a phrase with insufficient antecedent basis. By way of amendments made to claim 1, to which claim 4 indirectly refers, Applicant has provided sufficient antecedent basis to claim 4.

Claims 7-9 and 18-20 stand rejected under 35 USC 112 as reciting the limitation 'electrodes' without sufficient antecendent basis. Applicant has cancelled claims 9 and 20 and accordingly amended claims 7-8 and 18-19

Claims 12 and 14-20 stand rejected under 35 USC 112 as failing to point out to which electrode the Fermi level referred to belong. Applicant has accordingly amended claim 12 to clarify this.

Claims Rejections – 35 USC 102(b)

Claims 11-19 of the present invention concern methods to do with electron tunneling. The two references cited in support of a rejection under 35 USC 102(b) are to do with thermionic emission, a process Examiner will readily appreciate is a ballistic emission of electrons into a space between an emitter electrode and a collector electrode. These are figuratively shown in Figure 8 of Bell as elements **42**. None of the teachings of Cox or Bell have any bearing on a quantum mechanical tunneling process, and the methods taught in these two pieces of prior art have no value in providing improved approaches to exploiting electron tunneling.

Because an alleged identical invention must show in as complete detail as is shown in the supposedly anticipated claim, and Cox and Bell do not provide such detail, Applicant respectfully requests that Examiner withdraw the rejections of claims 11-14, 16 and 20 as being anticipated by Cox, and of claims 11-17 and 20 as being anticipated by Bell.

Rejections of claims 1-3, 5, 9-14, 16 and 20 under 35 USC 102(b) as being anticipated by COX

Claims 1-3, 5, 9-14, 16 and 20 stand rejected under 35 USC 102(b) as being anticipated by Cox (6,064,137).

To anticipate a claim, the prior art reference must teach every aspect of the claim. Furthermore the alleged identical invention must show in as complete detail as is shown in the supposedly anticipated claim.

Cox teaches two electrodes (a cathode **4** and an anode **8**) both coated with diamond or carbon-like diamond material (**6**), and separated from each other by means of spacers (**8**), and, in Figure 5, having an insulating film **30**.

In claims 1, 3, 5, 9-14 and 20 of the present invention, only the collector electrode (anode) comprises a band-gap material.

In claims 1-3, 5, 9-14, 16 and 20 of the present invention, neither the emitter nor the collector are coated with an insulating film.

Furthermore, it can be seen from Figures 1, 1A, 3 and 3B of the present invention, and the associated descriptive text, that the emitter and collector are separated by a gap, not by spacers. Applicant has amended claims 1-3, 5, 10-13 and 15 to include this limitation.

Furthermore, regarding claims 1 and 5, Cox's anode comprises a diamond or diamond like material placed on top of a conductive anode (Col. 8, lines 49-50). Cox specifies that 'the body of the anode is a conductive plate' (Col. 10, line 44). Cox's anode comprises an additional metal base layer in comparison to the collector or anode of the present invention which can function comprising a band gap material alone.

In view of the amendment made to Claims 1, 11 and 12 and the arguments above, Applicant suggests that Cox does not anticipate the current invention and Applicant therefore respectfully requests that Examiner withdraw his rejection of claims 1-3, 5, 9-13 and 15 under 35 USC 102(b).

Rejections of claims 1, 3, 5, 9-14, 16 and 20 under 35 USC 102(b) as being anticipated by BELL

Claims 1, 3-6, 9-17 and 20 are rejected under 35 USC 102(b) as being anticipated by Bell (4,280,074).

To anticipate a claim, the prior art reference must teach every aspect of the claim. Furthermore the alleged identical invention must show in as complete detail as is shown in the supposedly anticipated claim.

Bell teaches two electrodes, an emitter **35** and a collector **36**, in which the collector is coated with a composite layer comprising: a heavily-doped p-type semiconductor layer **25** exposed at the surface to a work function lowering activator, such as a cesium vapor; n-type semiconductor layer **26**; and heavily doped n+ contact region **27** formed on metal **28**. On top of the composite

layer is a topside contact 47. Furthermore, the p-n junction is maintained in a forward biased condition (see abstract).

In claims 1, 3-6, 9-17 and 20 of the present invention, the collector electrode does not comprise a cesiated layer, nor does the gap between the electrodes comprise a work function lowering activator, such as a cesium vapor; this latter is made clear by the scope of claims 9 and 20.

Applicant has therefore included the limitation that the gap between the electrodes is evacuated or filled with an inert gas under low pressure into claims 1, 12 and 13.

Furthermore, with regards to claims 12, 16 and 17, Examiner states that Bell discloses a method for reducing back tunneling of electrons in a diode, in which the collector is positioned at a distance within the tunneling range of electrons from an emitter.

As pointed out, Bell's device is a thermionic converter rather than a tunneling diode. There is therefore no inherent limitation on the distance between the electrodes as there is for a tunneling diode of the present invention. Indeed, Bell's only reference to the inter-electrode separation is in terms of space charge effects (Col. 1, lines 27-29) rather than as pertains to electron transport. Nowhere in the specification does Bell disclose an inter-electrode separation; this is as expected, since Bell's invention, as a thermionic converter, is not of a nature to require a specialised electrode separation. There is therefore no indication in Bell that the collector is positioned within the tunneling range of electrons from an emitter.

In view of these arguments Applicant respectfully suggests that Bell does not anticipate the present invention in claims 1, 3-6 and 9-16. Applicant therefore respectfully requests that Examiner withdraw his rejection of these claims under 35 USC 102 (b).

Claims Rejections – 35 USC 103(a)

Claims 7, 8, 18 and 19 stand rejected under 35 USC 103 as being unpatentable over Cox (6, 064, 137) in view of Tavkhelidze et. al. (6,417,060). In view of the amendments made to claim 1, 11 and 12 and the corresponding arguments above, Applicant believes that claims 7, 8, 17 and 18 are patentable over the prior art of Cox in view of Tavkhelidze due to the significant differences between Cox's invention and the current invention.

Furthermore, Examiner argues that 'since both Cox and Tavkhelidze teach a tunnel diode' it would be obvious to one skilled in the art to combine the inter-electrode separation of Tavkelidze with the diode of Cox. However, Cox does not teach a tunnel diode. Cox's invention is a thermionic emitter in which 'the exact emission mechanism is not well understood' (Col. 5, lines 53-54) and electrons travel from emitter to collector electrodes due to a temperature gradient (Col. 7, lines 1-2). Applicant therefore believes that it would not be obvious to combine features of Cox with Tavkhelidze since the two devices function differently and therefore do not necessarily lend themselves to equal electrode separation.

Furthermore, Cox explicitly teaches away from the 5 nm gap suggested by Examiner. Cox specifies (Col. 9, line 51) a cathode - anode spacing of 0.5μm or 500 nm. In addition, Cox advertises that one of the advantages of his device is the potential for setting the cathode and anode 'at greater distances from each other than has been previously envisaged', indicating that the 500 nm spacing specified is a minimum limit to be increased upon, rather than reduced 100 fold.

Examiner additionally argues that the claimed ranges of claims 7, 8, 18 and 19 are prima facie obvious in that they do not achieve unexpected results relative to the prior art ranges. However, as shown above, the claimed range is not an optimization of the prior art range – rather, the range pertains to a completely different field of art. The prior art mechanism of thermionic emission would gain no benefit from implementation of the claimed ranges.

Claims 7, 8, 18 and 19 stand rejected under 35 USC 103 as being unpatentable over Bell (4, 280, 074) in view of Tavkhelidze et. al. (6,417,060). Due to the cancellation of claims 9 and 20, these correspond to claims 7, 8, 17 and 18 in the current claims list.

In view of the arguments above, Applicant believes that claims 7, 8, 17 and 18 are patentable over the prior art of Bell in view of Tavkhelidze due to the significant differences between Bell's collector electrode and the collector electrode of the current invention.

Furthermore, Examiner argues that 'since both Bell and Tavkhelidze teach a tunnel diode' it would be obvious to one skilled in the art to combine the inter-electrode separation of Tavkelidze

with the diode of Bell. However, Bell does not teach a tunnel diode. Bell's invention is a thermionic converter in which a heat source and sink provide the temperature differential required for electrons to travel between the electrodes (Figs.1 and 8). Applicant believes that it would not be obvious to combine features of Bell with Tavkhelidze since the two devices belong to different fields in which the interelectrode separation has totally different significance.

Double Patenting

Applicant will timely file a terminal disclaimer should claims 1-9 and 11-15 of copending Application No. 11/392,182 be patented before claims 1-20 of the present application.

Applicant respectfully submits that this application, as amended, is in condition for allowance, and such disposition is earnestly solicited. No new material has been added by these amendments. If the Examiner believes that discussing the application the Applicant over the telephone might advance prosecution, Applicant would welcome the opportunity to do so.

Respectfully submitted,
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